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A Study of Erodibility of Aramoko-Ekiti Soil, Southwestern Nigeria

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Abstract
Knowledge of soil erodibility is important for investigation and prediction of soil movement, which will help in lives and properties safety. This piece of study looked into erodibility of Aramoko-Ekiti soil. Soil samples were taken from four locations in the study area to laboratory for grain size distribution tests. Landforms (slopes) for those locations were also determined. Results showed that all the soil samples had very high percentages of clay (or silt) and sand, which varied between 38.18 and 46.70%, 51.90 and 59.42% respectively. And very low percentages of gravel, which varied between 1.30 and 2.40%. They have significant constituent materials of mainly silty or clayey sandy soils with little gravel. These implied that the soils are sediments and prone to erodibility. Slope steepness in the study area ranges from 0.05 to 0.104. This portrayed that the slopes were steep, thus favoured high soil erodibility.

Keywords: Erodibility, Grain size, Gully, Landform, Rill

1. Introduction
The earth's landforms are closely inter-related and some of the observation, which have been made with the passing of time, shows that these landforms are acted upon by the processes of erosion causing the landforms to undergo a progressive change from initial form sequentially to ultimate forms. The steeper the slope of land, the greater the amount of soil loss from erosion by water [4].

Basically, the steeper the slope of an area, the greater the amount of soil erosion caused by water. Soil erosion of water also increased with slope length due to the greater accumulation of runoff. The consolidation of small fields into larger results is often no longer the slope length of the potential for erosion, because water with an increase rate that allows a greater degree of scouring (carrying capacity of the sediment). Where land slopes are exceptionally steep and runoff from storms is exceptionally heavy, sheet erosion progresses into more intense activities than that of result in rill erosion or rilling in which innumerable closely spaced channels called shoestring rills are scored into the soil tillage; they soon begin to integrate into layer channels termed gullies. Erosion action thus is converted into a few large channels whose upper grow progressively upslope. The natural soil with its organic matters, nutrient and its well-developed horizons is non-renewable natural resources [4].

Soil erodibility is an estimate of the ability of soils to resist erosion in term of the physical characteristics of soil [8]. Knowledge of soil erodibility has to do with catchment of the sediment yield and is important for accurate prediction and investigation of the nutrients movements, contaminants and efficient management strategies. Source of soil erosion must be identified and sediment sources, which are differed in different spatial and temporal scales at different environmental conditions, must be diagnosed. An appropriate diagnosis fosters cost and effort optimization especially in agricultural areas where economic or management restrictions are common [9].

To some extent, the soil type governs land use. Climate erosivity, flow energy due to high slope, low soil cover related with water competition usually result in high susceptibility of water erosion; thus a major risk of soil and water weathering. Though, from early 2000s to date, some agro-environmental measures have been applied to reduce soil erosion, there is

still need for provision of clear management strategies adapted to the geophysical characteristics of the landscape as well as its economic restrictions. Thus, different erosive processes such as splash, rills, gullies etc. have led to some erosion control measures [9].

Past research works of [9] and others focused on the relevant topics in terms of soil erosion process as well as its parameters and factors. Moreover, the literature reviews also looked into the management and control of soil erosion. This piece of study sought to assess erodibility of Aramoko-ekiti soil, which usually lead to rill and gully erosion developments in the study area. This will lead to provision of information that will help in Government mitigation efforts in the area. Thus, help in saving of lives and properties in the study area.

1.1Study Area

The study area is Aramoko-Ekiti, which is the headquarter of Ekiti West Local Government in Ekiti state, Nigeria as shown in fig 1. According to [1, 3], Ekiti is a state in Southwestern part of Nigeria with sixteen Local Government Areas (LGAs). It is one of the thirty-six states of Nigeria and mainly an upland zone, rising over 250 meters above sea level. It lies on an area underlain by metamorphic rock and universally undulating country with a landscape feature that comprises of old plains broken by step-sided out-crops that may occur singularly or in groups or ridges. Such out-crops rocks exist mainly in Aramoko (i.e. the study area), Efon-Alaaye, Ikere-Ekiti,Igbara-odo-Ekiti and Okemesi-Ekiti. The State is dotted with rugged hills, notable ones being Ikere-Ekiti hills in the south, Efon-Alaaye hills on the western boundary and Ado-Ekiti hills in the centre. The State has tropical climate with two distinct seasons, which are rainy and dry season. Temperature is between 21° and 28 °C with high humidity. The southwesterly and the northeast trade winds blow in the rainy and dry seasons respectively.

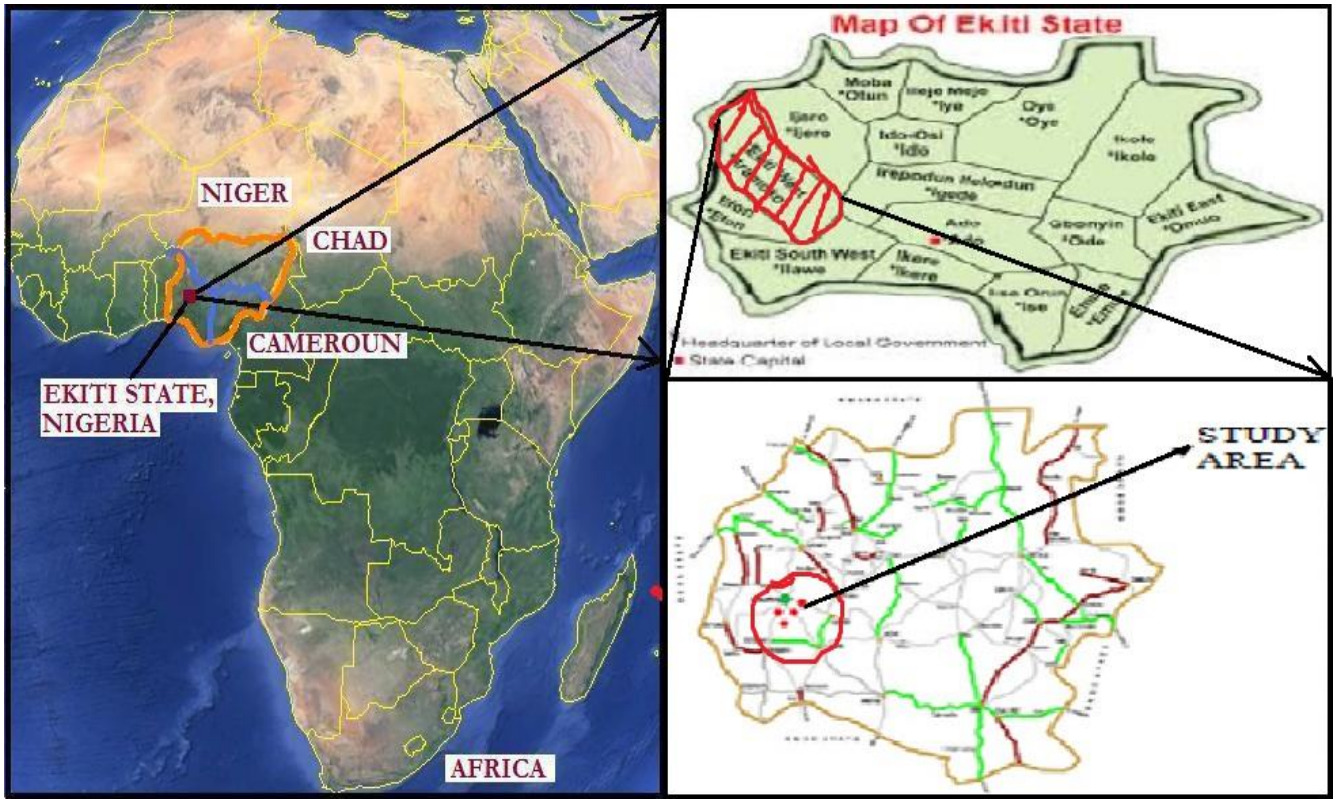

Fig 1: The map showing the location of the study area – Atiba, Alele, Ikoyi and Iloro of Aramoko-Ekiti.

1.2 Grain size distribution test

This test is used in determining particles or grains distribution, particles sizes and relative proportion by mass of soil types (i.e. clay, sand and gravel fraction) for typical samples. The results are always grouped in accordance with [6, 7] [1].

2. Materials and methods

Soil samples were taken along the rills and gullies in the study area from four locations namely Atiba, Alele, Ikoyi and Iloro. Coordinates of the locations were taken as shown in Table 1. The soil samples collected were stored in polythene bag to maintain its natural moisture contents. The samples were then taken to the laboratory where the unwanted materials such as roots were removed. The samples were air dried, pulverized and large particles were removed. Moulding of test specimens was started as soon as possible after completion of identification. All tests were performed to standards as in [5]. Their features were also examined. Readings were also obtained at interval of 20 meters using GPS. The test carried out on the samples was Grain Size Distribution. The results were compared to the standard specified values and grouped in accordance with [6, 7].

Table 1: Details of the soil samples

LOCATION	EASTINGS	NORTHINGS
ATIBA	$7^0$42’23.65”	$5^0$2’39.32”
ALELE	$7^0$42’23.26”	$5^0$2’38.21”
IKOYI	$7^0$42’23.43”	$5^0$2’37.31”
ILORO	$7^0$42’23.22”	$5^0$2’38.22”

Results and discussion

Table 2: Summary of Grain Size test results for the samples

SOIL SAMPLE	GRAIN SIZE DISTRIBUTION		
	GRAVEL (%)	SAND (%)	SILT / CLAY (%)
ATIBA	1.40	51.90	46.70
ILORO	1.30	58.14	40.56
IKOYI	2.40	59.42	38.18
ALELE	1.96	53.70	44.34
UPPER LIMIT	35.00	68.00	14.00
LOWER LIMIT	18.00	58.00	7.00

Table 2 showed results of Grain size analysis test for the soil samples from the study area. The results showed that all the soil samples had very high percentages of clay or silt, which varied between 38.18% and 46.70% and did not meet required specification (7 – 14%) in accordance with AASHTO (1986). Iloro (58.14%) and Ikoyi (59.42%) soil samples met required specification, while Atiba (51.90%) and Alele (53.70%) did not meet required specification (58 – 68%) for sand. No soil samples met required specification (18 – 35%) for gravel. The general rating as sub-grade is fair to poor materials. They have significant constituent materials of mainly silty clayey sandy soils with few gravels. These results portrayed that the soil in the study area is prone to erodibility because the percentage of sum of sand and silt / clay is greater than 68% (upper limit), while that of gravel is below 18% (lower limit) for all the soil samples. The higher the percentage of gravel, the lesser the erodibility of the soil. Furthermore, these results also indicated that the soils in the study area are sediments [9].

Table 3: Summary of Landform (Slope) results

LOCATION	SLOPE (Δy/Δx)
ATIBA	0.104
ALELE	0.106
IKOYI	0.056
ILORO	0.050

Table 3 showed results of landform (slope) results for the soil samples from the study area. It was observed that the steepness in slope in the study area ranges from 0.05 to 0.104. According to [2], the steepness of slope that falls between the values of 0.001 to 0.01 favoured low erosion and runoff, while the value of steepness of slope greater than 0.01 favoured high erosion and runoff thereby increasing the cutting rate of the soil. The steeper the slope of land, the greater the amount of soil loss from erosion by water. Therefore, the steepness of slope of land around Ikoyi and Iloro will favour low erosion and runoff in the area compared to that of Atiba and Alele, which supported high erosion, and runoff. Alele and Iloro area soils have the highest and lowest erodibilities respectively. Generally, soil erodibility in the study area is in order of Alele > Atiba > Ikoyi > Iloro.

Conclusion

The following conclusions were drawn based on the above study:

1. There are presence of large quantities of clay, silt, sand and less quantity of gravel. This is a good indication for high soil erodibility
2. These could be due to deposition process
3. The slopes in the study area are steep, thus favoured high erosion and runoff. Thus, result in high soil erodibility.
4. Soil erodibility in the study area is in order of Alele > Atiba > Ikoyi > Iloro.

Based on the above conclusions, it is recommended that the impact of soil erosion on the affected area should be thoroughly assessed with a view to find everlasting solution to it. Further study should also be carried out.

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